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## ON BALLS OF VEGETABLE MATTER FROM SANDY SHORES.

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IT happened some two or three years ago that I received at about the same time from two different sources inquiries as to the mode of formation of certain balls of vegetable matter found on the sandy bottoms of shallow ponds. Having myself no knowledge of the subject I sought for some description of them in the accessible literature, but without result. Nor did inquiries addressed to those of my colleagues likely to be versed in such matters elicit any substantial information. Following the subject further, however, I did obtain some facts about them, and, since other interests are not likely to allow me to investigate their mode of formation for myself, I desire to place these facts on record for the benefit of others who may wish to make use of them.

The earliest, and at the same time almost the only, published reference to the balls known to me occurs in Thoreau's well-known book, *Walden*, the first edition of which appeared in 1854. In the Chapter on Ponds, in a description of Flint's or Sandy Pond in Lincoln, Mass., he writes:—

There also I have found, in considerable quantities, curious balls, composed apparently of fine grass or roots, of pipewort perhaps, from half an inch to four inches in diameter, and perfectly spherical. These wash back and forth in shallow water on a sandy bottom, and are sometimes cast on the shore. They are either solid grass, or have a little sand in the middle. At first you would say that they were formed by the action of the waves, like a pebble; yet the smallest are made of equally coarse materials, half an inch long, and they are produced only at one season of the year. Moreover, the

waves, I suspect, do not so much construct as wear down a material which has already acquired consistency. They preserve their form when dry for an indefinite period.

Apparently this is Thoreau's only published reference to the balls. But I am informed by Mr. Francis H. Allen, of West Roxbury, that Thoreau's manuscript Journals now in his possession in preparation for publication by Messrs. Houghton, Mifflin & Co., contain two additional references to them, and these references, by Mr. Allen's kind aid and permission, are here reproduced:—

Feb. 4, 1857. Met Theodore Parker in the cars, who told me that he had recently found in Lake Michigan a single ball five inches in diameter like those I presented to the Natural History Society, though he did not observe the eriocaulon. It was late in the season.

Apr. 5, 1858. In the proceedings of the Natural History Society for December, 1856, there were presented by Dr. H. R. Storer 'a globular concretion of grass said to have been formed by the action of waves upon the sea shore'. Were not these some obtained by the Hoars or Emersons from F. Pond?

The reference in this passage is to the *Proceedings of the Boston Society of Natural History*, Vol. 6 (published 1857), page 93, where the citation given by Thoreau occurs. The specimen itself, however, is not now in the Society's Museum, as I am informed by the Secretary, Mr. Glover M. Allen.

The mention of the balls in a work so notable as *Walden* has apparently drawn much attention to them locally, and has led those of Thoreau's readers who possess scientific tastes to desire further information concerning them. It was for this reason that the first of these balls I had seen were sent me by Miss Madge Palmer of the Packer Collegiate Institute, of Brooklyn. Somewhat later I received a letter (Oct. 5, 1901) on the subject from the late Alfred W. Hosmer of Concord (who speaks of them as grass balls), in the course of which he writes:

The *eastern* side of the pond [Flint's or Sandy Pond] is a shallow place, the bottom of a hard white sand, covered with ripple marks. In these ripple marks there collects decayed eriocaulon, or duck grass, and the prevailing winds in summer being *west*, these bits of decayed grass are gently rolled together, and as the ball forms, it begins a wider rolling, gathering new bits on its way, until they form balls from one to four inches in diameter. If they keep under water while in process of formation, they keep spherical, but if they are washed up to shore, the action of the waves flattens them. Break one open while wet, and it cannot be made to adhere again and will go to

pieces; break one while dry, and it holds. All I have opened have been composed of the same substance all through, and of the quantity I have picked up in the past 8 or 10 years, only two have had a different substance in them. One had a portion of a chestnut burr, and the other a piece of a woody plant with roots on it — the plant was dead, however — this one is egg shaped. As the balls begin to form they are very loosely put together but become matted from long rolling. I find them the latter part of August and first of September, only in the one section of the pond, and then only when the pond is full. . . . As to their keeping qualities when dry, there is one in the possession of the Concord Antiquarian Society that Thoreau found, and he has been dead 39 years.

Another account of the formation of the Sandy Pond balls has been sent me by Mr. Joseph S. Richardson of Concord, Mass. He confirms Mr. Hosmer's statements excepting as to the precise place of occurrence of the balls, which Mr. Richardson places in a cove at the north side of the pond. More recently I have been able to see, through the courtesy of Professor B. L. Robinson of the Gray Herbarium, a MS. description of these balls, without date, written by William A. Hart and now in the library of the Gray Herbarium. After describing their formation from *Eriocaulon* stems, the author adds:

The broken stems first collect in the little ripples of the sand; then a changed direction of waves gives them a new motion and they soon form into spheres or cylinders. After attaining some size they roll freely about, in water about two feet deep and less, on the bottom and continue to collect more material. Naturally they form in coves where the eddying of waves is suited for the varied motion necessary to form them. They were discovered by the writer in Sandy Pond, Lincoln, Mass., and so far as he can learn occur elsewhere only in Lake Geneva, Switzerland.

This reference to the occurrence of such balls in Lake Geneva is not confirmed by any information I possess, nor do I know Mr. Hart's authority for the statement, which, however, is very likely correct.

Yet another, and in some respects markedly different description of the Sandy Pond balls has been sent me by Mr. Lincoln Ware Riddle, of Cambridge, Mass., who writes:—

In the summer of 1898 I found over twenty specimens on the northern shore of Sandy Pond, Lincoln, Mass. They are called by the people of that neighborhood, "Burr Balls." There is comparatively little *Eriocaulon* growing in Sandy Pond; but the shores, especially to the north are bordered by a large number of chestnut trees.

I should say that the balls were composed chiefly of the debris of the chestnut burrs, with some admixture of the veins of rotted leaves. I have found them from an inch in diameter, in which case they are flattened and loosely compacted, up to six inches, when they are perfectly spherical and closely compacted. The northern shore of the pond is shallow for a long distance out, and the prevailing southerly winds of summer would roll the waves on the shore. The summer of 1898 was one of extreme low water; the following years the water rose several feet, and I was unable to find a single Burr-ball.

Mr. Riddle is evidently not certain as to the composition of the Sandy Pond balls, and while it is entirely possible that some composed of the debris of chestnut burrs may occur in the pond, it is likely they are all of *Eriocaulon*, as the other observers have stated. Certainly the several specimens I have received from Mr. Hosmer and Mr. Richardson, and one of which is figured on the accompanying plate, are composed of *Eriocaulon* almost exclusively.

So much for the information I have obtained about the balls from Sandy Pond. Meanwhile I was shown at Fredericton by Professor L. W. Bailey, of the University of New Brunswick, a very fine specimen, of similar formation but very different material, said to have been found in Kedron Lake in the southwestern part of York County, New Brunswick. Following up the matter I found that it had been obtained by Mr. Wellington Davis of Brockway, N. B., from Little Kedron Lake, and on application to Mr. Davis he sent me a fine specimen together with the following account of its formation:—

It is found in the north end of Little Kedron Lake in a small cove. No wind can strike the cove but from the southeast. It is surrounded with fir and spruce which hang over the water. The bottom is a clear sand. The spills drop from the fir and spruce and lie at the bottom. Then the water washing from side to side forms the ball. No heavy swell comes in there. These balls can be found in no other place in the Little Kedron Lake nor in Big Kedron Lake. Sometimes we have found them from six to eight inches through.

This account, with other matter relating to this subject (practically all included in the present paper), together with a plate showing the ball beside one from Sandy Pond, were published in the *Educational Review* (St. John, N. B.) for August, 1904 (page 51), and it appears in somewhat altered form in the *Bulletin of the Natural History Society of New Brunswick*, No. XXIII, 1905. As Mr. Davis states, the balls consist almost exclusively of the spills (*viz.* leaves or needles) of the spruce, which are interlocked in a very compact and fairly tenacious mass. It is very remarkable that such smooth objects

can thus cling together, but still more remarkable that they should become interlocked in this way in the first place; and one suspects that some cement of micro-organisms must be present to account for their cohesion, something of which the dried specimens show no evidence.

Desiring information as to other localities, or as to other published references to the subject, I published in *Science* for April 8th (1904), a letter asking for such information. It was this letter which brought me the welcome information above given from Mr. Allen and Mr. Riddle; and, in addition, Mr. F. V. Coville of Washington referred me to similar balls from lakes in Idaho, and gave me the name of a botanist, Mr. John B. Leiberg of Athol, Idaho, who was acquainted with them. On application to Mr. Leiberg he kindly wrote me (May 5, 1904) as follows:—

Balls and solid cylinders composed, in the main, of decaying pine needles, bits of comminuted bark and wood, *Ceratophyllum demersum*, leaves and stems of *Potamogeta*, *Charas* and *Nitellas* are of common occurrence in Lake Pend Oreille, in Idaho, and doubtless in Priest and Coeur d'Alene lakes also, in the same State. The balls are small affairs — 4 to 7 centimeters in diameter — while the cylinders vary from 30 to 40 centimeters in length, with diameters from 3 to 5 centimeters. Owing to the great depth of the lakes the balls and cylinders are formed near the shores in water less than 1 meter in depth, and mostly in late summer and fall; the strong gales and heavy wave motion of early winter soon destroy them. The nucleus both of balls and cylinders consists of broken and tangled bits of *Ceratophyllum*, *Charas* and *Nitellas*, occasionally mixed with strands of *Zannichellia* and *Naias*. The wave motion rolls the mixture along the bottom and in its progress shoreward pine-needles, decaying splinters of wood bark and similar debris are taken up and become intimately mixed with the primary mass. Infusorial slimes — *Amoebas*, *Vorticellas*, etc.— develop and assist in holding the mass together. It is finally cast up on shore where wind and wave soon bring about its disintegration. The balls and cylinders have no local designation.

Mr. Leiberg's account, it will be observed, apparently leaves little to be said as to the mode of origin of the balls in the lakes of his region.

All of the balls so far described occur in fresh-water lakes. I have however seen a specimen, of apparently a similar general nature, from a sea-beach. It was sent me by Mr. Francis H. Allen, and is from Ipswich Beach. As compared with the lake balls I have seen, it is much smaller, far less regular, and of much coarser and more hetero-

geneous materials, — in fact little more than a loosely-matted collection of flotsam hardly brought to a true ball by wave-action.

There remain to add a few facts about vegetable balls of a totally different morphological origin, of which three distinct kinds are known to me. *First*, there are the photo-bezoars, mentioned occasionally in botanical literature, which are formed of matted grass-awns, cactus-bristles, etc. in the stomachs of herbivorous animals. *Second*, the letter in *Science*, above mentioned, was followed by two others in later numbers of that journal (XIX, 926 and XX, 86) by J. Adams of the Royal College of Science of Dublin, giving references to balls formed by the alga *Cladophora* in Scottish and Danish Lakes. I am informed, however, by Professor F. E. Lloyd and by Dr. M. A. Howe, that the balls formed by these Algae, of which there are specimens in the Museum of the New York Botanical Garden, are of a character quite different from that of the ones we are here considering, for the balls of *Cladophora* are the result of the normal mode of growth of the plant, and are not simply mechanically-produced aggregations. *Third*, Mr. John H. Sears, of the Peabody Museum at Salem, Mass., writes me (Feb. 9, 1905) that he finds on Ipswich and other beaches a kind of vegetable ball, or "pebble," formed from the matted sods of *Juncus Gerardi*, or Black Grass, thrown upon beaches in ditching operations. These sods are rolled about, worn down and rounded by action of the waves; and they may in addition pick up in the process various other materials,— grass fragments, bits of wood, fish-bones and even sand. Obviously such balls are very different in origin from those of the fresh-water ponds. Mr. Sears also adds that he has found vegetable balls on the shores of Wenham Lake.

There are, therefore, at least four morphologically distinct modes of origin for balls of vegetable matter, and very likely there are also others.

Returning for a moment to the particular kind here under consideration, it seems plain from the descriptions cited that they are simply an incidental mechanical result of the rolling about of light water-logged materials on sandy bottoms by the under-water parts of waves, aided perhaps as to their cohesion by the development of glutinous micro-organisms. On this basis the balls ought to occur wherever this combination of conditions is found, and hence in some parts of most shallow sandy-bottomed lakes; and it is surprising that

they appear to have been so little observed. While this is their probable mode of origin, the subject should by no means be allowed to rest with conjecture, but the genesis and growth of the balls should receive precise scientific study and adequate description.

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## AN UNDESCRIBED NORTHERN COMANDRA.

M. L. FERNALD.

IN July, 1903, Mr. George H. Richards collected in the sandy alluvium of the Grand River, Gaspé County, Quebec, a white-flowered *Comandra*, which in habit suggested both *C. umbellata*, Nutt., of the Atlantic States and *C. pallida*, A. DC., of the extreme West. The specimens were not, however, satisfactorily referable to either of those species; so in late June and early July when, with Mr. Richards, I visited the salmon-camp of Mr. Louis Cabot, the present owner of the Seigniory of Grand River, we made it a special point to search for the strange *Comandra*. The plant was found at several stations, but only occasionally in flower. Later in July, it was found in dry sandy woods at Tadousac, at the mouth of the Saguenay, and in September was collected in ripe fruit at the same station.

Study of this *Comandra* of eastern Quebec shows that it is a plant of broad northern range, extending across Canada to Saskatchewan and Assiniboia, south to the Great Lakes, Missouri, and Kansas. Throughout this extensive range the plant holds the characteristics noted on the Grand River and at Tadousac. Compared with *C. umbellata* of the Eastern States,—from central Maine to Wisconsin and Georgia—the more northern species is low, the fertile branches 0.5–2.5 dm. high, those of *C. umbellata* ranging from 1.5–4 dm.; the more crowded leaves are thicker, scarcely paler beneath, and when dry with green inconspicuous reticulate veins, the fewer thinner leaves of *C. umbellata* being somewhat whitened beneath and with the pale midrib prominent beneath. The inflorescence of the northern plant is a rather dense corymb, made up of 2–6-flowered cymules on strongly ascending rays; that of *C. umbellata* is an ellipsoid-oblong panicle with the cymules of smaller more numerous flowers on divergent rays.